Serial No. 10/022,594
Docket No. 396290/00

REMARKS

Claims 1-52 are all the claims presently pending in the application.

It is noted that the claim amendments (if any) are made only for more particularly pointing out the invention, and not for distinguishing the invention over the prior art, narrowing the claims or for any statutory requirements of patentability. Further, Applicant specifically states that no amendment to any claim herein should be construed as a disclaimer of any interest in or right to an equivalent of any element or feature of the amended claim.

Claims 5-13 and 31-39 are allowed. Applicant gratefully acknowledges that claims 15, 26, 41, and 52 would be allowable if rewritten in independent form. However, Applicant respectfully submits that all of the claims are allowable, when properly interpreted consistent with the plain meaning of the claim language in the independent claims, as clarified in the discussion below.

Claims 1-4, 14, 16-25, 27-30, 40, and 42-51 stand rejected under 35 U.S.C. § 103(a) as unpatentable over U.S. Patent No. 6,134,245 to Scarmalis, further in view of "Generic Framing Procedure (GFP) Specification", October 9-13, 2000, by Hernandez-Valencia (Ed.).

This rejection is respectfully traversed in the following discussion.

I. THE CLAIMED INVENTION

The claimed invention is directed to a GFP frame transfer apparatus for transferring a GFP (Generic Frame Procedure) frame over a GFP network. An FCS generation section generates, when the GFP frame is generated and sent by the GFP frame transfer apparatus, an FCS (Frame Check Sequence) using the payload *field* of the GFP frame as the generation target area and adds this FCS to the FCS field of the GFP frame.

As explained beginning at line 13 on page 6, conventional methods update the payload header and recalculate the FCS. Although it is possible to perform monitoring in ring units using the FCS field, it is not possible to perform monitoring of the end-to-end path from the SONET node of Ingress to the SONET node of Egress.

The claimed invention, on the other hand, provides a method for performance monitoring of an end-to-end path using the FCS field of a GFP frame. It achieves this capability by generating an FCS using the payload of the GFP frame as the generation target area and adding this to the FCS field of the GFP frame.

II. THE PRIOR ART REJECTION

The Examiner alleges that Scarmalis, further in view of Hernandez-Valencia, renders obvious the claimed invention as defined by claims 1-4, 14, 16-25, 27-30, 40, and 42-51. Applicant submits, however, that there are elements of the claimed invention which are neither taught nor suggested by Scarmalis, even if modified by Hernandez-Valencia.

The Examiner seems to maintain the rejection by considering that adding new FCS to the FCS field of the GFP frame is obvious to the person having ordinary skill in the art. However, Applicants submit that this is not an aspect of the present invention that is particularly significant compared to the conventional method.

That is, more significant is that the target area for a conventional FCS calculation corresponds to the entire payload area of the GFP frame, while the target area of the present invention corresponds to the payload (field) part *without* the payload header (p.25, line 27, to 26, line 3, in the specification of the present application).

Thus, in Enrique Hernandex-Valencia, the area corresponds to the entire payload area. Also, in Scamalis, the area corresponds to the entire area of the HDLS packet excluding a begin flag and an end flag (col. 65, line 51—col.7, line 8 in Scamalis). Both of these references are different from the present invention in the target area for FCS calculation.

In the cited references, the fields in the payload header of the GFP frame (or HDLC packet) is rewritten at each node that terminates the GFP frame (or HDLC packet), so that FCS is recalculated and rewritten at the node (p.6, lines 6-13 in the specification). On the other hand, the present invention does not need both recalculating and rewriting at the node, since the target area for calculating FCS does not have the payload header (p.25, line 27 to p.26, line 6 in the specification).

The target area for a FCS calculation of the present invention corresponds to the payload files without payload header. The target area for a conventional FCS calculation corresponds to entire area of the payload area (including payload header).

The Examiner's continued rejection suggests a failure to recognize this significant difference of the respective target areas.

The reference US 6,134,245 (Scarmalis) does not include the above subject matter of the present invention. Applicants explain the frame format and the target area for FCS calculation of Scarmalis in the following discussion.

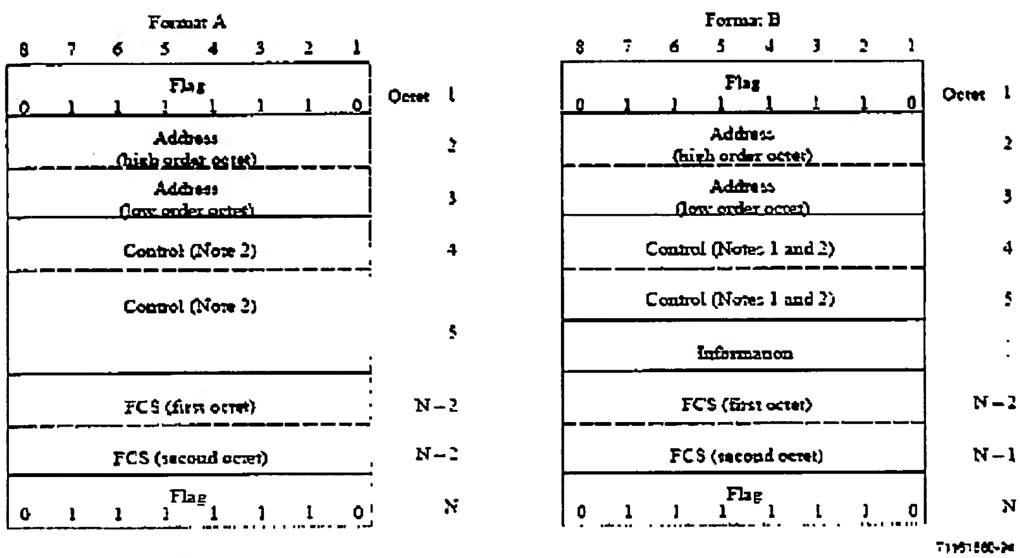
The frame format shown in Fig.5 in Scarmalis is the Frame Relay format, which is

Serial No. 10/022,594
Docket No. 396290/00

specified in ITU-T Recommendation Q.921 and Q.922. For the information of the Examiner, the front cover page of each of these two ITU publications is attached to this paper, along with a copy of selected pages mentioned below. It is noted that, because these documents are publicly available and quite lengthy (e.g., 269 pages and 112 pages, respectively), Applicants have not submitted a complete copy but can do so if the Examiner considers such complete documents should be added to the file and contacts Applicants' representative at the contact information at the end of this paper.

The specification of the frame format is described in "Figure1/Q.921 - Frame formats" of ITU-T Q.921 and the specification of Frame Relay is described in Annex A of ITU-T Q.922. The format corresponds to Format B in "Figure1/Q.921 - Frame formats" of ITU-T Q.921, which is copied below as an imported figure.

Q.921.



NOTE 1 – For unacknowledged operation, format B applies and one octet control field is used.
NOTE 2 – For multiple frame operation, frames with sequence numbers contain a two-octet control field and frames without sequence numbers contain a one-octet control field. Connection management information transfer frames contain a one-octet control field

Figure 1/Q.921 – Frame formats

The target area for FCS calculation in Frame Relay (which is Scarmalis's target area) is described in Section 2.7 "Frame Check Sequence (FCS) field" of ITU-T Q.921. That is, the target area for FCS calculation is from the next bit of the last bit of the start Flag (that is, first bit of the Address field) to the previous bit of FCS. Hence, the target area for FCS

Serial No. 10/022,594
Docket No. 396290/00

calculation in Frame Relay includes the Address field.

The specification of Address field in Frame Relay is described in Section 3 "Elements of procedures and formats of fields for data link layer peer-to-peer communication" and ANNEX-A "Core aspects of Q.922 for use with frame relaying bearer service" of ITU-T Q.922. The format in Frame Relay is described in p.31 FIGURE A-1/Q922 Frame relay frame format with two octet address of ITU-T Q.922, copied below as an imported figure.

8	7	6	5	4	3	2	1	
Flag								
0	1	1	1	1	1	1	0	Octet 1
High order octet of address field						(Note)		2
Low order octet of address field								3
								4
Frame relay information field								
								N-3
Frame check sequence (FCS) 1st octet								N-2
Frame check sequence (FCS) 2nd octet								N-1
Flag								
0	1	1	1	1	1	1	0	N

Note – The default address field length is 2 octets. It may be extended to either 3 or 4 octets bilateral agreement.

FIGURE A-1/Q922

Frame relay frame format with two octet address

Serial No. 10/022,594
Docket No. 396290/00

The specification of the Address filed format is described in FIGURE A-2/Q.922 Address field formats of ITU-T Q.922, copied below as an imported figure.

Default address field format (2 Bytes)

8	7	6	5	4	3	2	1
Upper DLCI						*	EA 0
Lower DLCI				FECN	BECN	DE	EA 1

or

3 octet address field format

8	7	6	5	4	3	2	1
Upper DLCI						*	EA 0
DLCI				FECN	BECN	DE	EA 0
Lower DLCI or DL-CORE control						D/C	EA 1

or

4 octet address field format

8	7	6	5	4	3	2	1
Upper DLCI						*	EA 0
DLCI				FECN	BECN	DE	EA 0
DLCI							EA 0
Lower DLCI or DL-CORE control						D/C	EA 1

D/C DLCI or DL-CORE control indicator (see § A.3.3.7)
DE Discard eligibility indicator (see § A.3.3.5)
EA Address field extension bit (see § A.3.3.1)
* Bit intended to support a command/response indication. The coding is application specific (see § A.3.3.2)
FECN Forward explicit congestion notification (see § A.3.3.3)
BECN Backward explicit congestion notification (see § A.3.3.4)
DLCI Data link connection identifier (see § A.3.3.6)

FIGURE A-2/Q.922
Address field formats

The bit of FECN, BECN and DE may be changed by the network-equipment in a route, as shown in Sections A.3.3.3, A.3.3.4 and A.3.3.5 (page 32-34) of ITU-T Q.922. Hence, in Frame Relay, the bit in the target area for FCS calculation may be changed in a network equipment in a route.

Applicants believe that the subject matter of the present invention is not disclosed in any reference and is not obvious from any reference currently of record.

Hence, turning to the clear language of the claimed invention, in neither Scarmalis nor Hernandez-Valencia is there a teaching or suggestion of: "...when said GFP frame is generated and sent by said GFP frame transfer apparatus, an FCS (Frame Check Sequence) using a payload *field* of said GFP frame as a generation target area and adds this FCS to the FCS field of said GFP frame", as required by independent claim 1. The remaining rejected independent claims have similar language.

Therefore, Applicants submit that there are elements of the claimed invention that are not taught or suggest by Scarmalis, even if modified by Hernandez-Valencia. Therefore, the Examiner is respectfully requested to reconsider and withdraw this rejection.

Applicants again respectfully submit that the rejection currently of record fails to provide a reasonable motivation to modify the primary reference. Moreover, even if the primary reference were to be modified, the basic deficiency identified above for the primary reference would still not be overcome.

III. FORMAL MATTERS AND CONCLUSION

In view of the foregoing, Applicant submits that claims 1-52, all the claims presently pending in the application, are patentably distinct over the prior art of record and are in condition for allowance. The Examiner is respectfully requested to pass the above application to issue at the earliest possible time.

Should the Examiner find the application to be other than in condition for allowance, the Examiner is requested to contact the undersigned at the local telephone number listed below to discuss any other changes deemed necessary in a telephonic or personal interview.

Serial No. 10/022,594
Docket No. 396290/00

The Commissioner is hereby authorized to charge any deficiency in fees or to credit any overpayment in fees to Attorney's Deposit Account No. 50-0481.

Respectfully Submitted,

Date: 4/12/06

Frederick E. Cooperrider
Registration No. 36,769

McGinn Intellectual Property Law Group, PLLC
8321 Old Courthouse Road, Suite 200
Vienna, VA 22182-3817
(703) 761-4100
Customer No. 21254

CERTIFICATION OF TRANSMISSION

I certify that I transmitted via facsimile to (571) 273-8300 this Amendment under 37 CFR §1.116 to Examiner S.C. Hom on April 12, 2006.

Frederick E. Cooperrider
Reg. No. 36,769

Attachment for Response S/N:10/022,594 filed 4/12/06

INTERNATIONAL TELECOMMUNICATION UNION

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

Q.921

(09/97)

SERIES Q: SWITCHING AND SIGNALLING

Digital subscriber Signalling System No. 1 – Data link layer

ISDN user-network interface – Data link layer specification

ITU-T Recommendation Q.921

(Previously CCITT Recommendation)

10/022,594

abort sequence is not simulated within the frame. A receiving data link layer entity shall examine the frame contents between the opening and closing flag sequences and shall discard any 0 bit which directly follows five contiguous 1 bits.

2.7 Frame Check Sequence (FCS) field

The FCS field shall be a 16-bit sequence. It shall be the ones complement of the sum (modulo 2) of:

a) the remainder of $x^k (x^{15} + x^{14} + x^{13} + x^{12} + x^{11} + x^{10} + x^9 + x^8 + x^7 + x^6 + x^5 + x^4 + x^3 + x^2 + x + 1)$ divided (modulo 2) by the generator polynomial $x^{16} + x^{12} + x^5 + 1$, where k is the number of bits in the frame existing between, but not including, the final bit of the opening flag and the first bit of the FCS, excluding bits inserted for transparency; and

b) the remainder of the division (modulo 2) by the generator polynomial $x^{16} + x^{12} + x^5 + 1$, of the product of x^{16} by the content of the frame existing between, but not including, the final bit of the opening flag and the first bit of the FCS, excluding bits inserted for transparency.

As a typical implementation at the transmitter, the initial content of the register of the device computing the remainder of the division is preset to all 1s and is then modified by division by the generator polynomial (as described above) on the address, control and information fields; the ones complement of the resulting remainder is transmitted as the 16-bit FCS.

As a typical implementation at the receiver, the initial content of the register of the device computing the remainder is preset to all 1s. The final remainder, after multiplication by x^{16} and then division (modulo 2) by the generator polynomial $x^{16} + x^{12} + x^5 + 1$ of the serial incoming protected bits and the FCS, will be 0001110100001111 (x^{15} through x^0, respectively) in the absence of transmission errors.

2.8 Format convention

2.8.1 Numbering convention

The basic convention used in this Recommendation is illustrated in Figure 2. The bits are grouped into octets. The bits of an octet are shown horizontally and are numbered from 1 to 8. Multiple octets are shown vertically and are numbered from 1 to n.

2.8.2 Order of bit transmission

The octets are transmitted in ascending numerical order; inside an octet bit 1 is the first bit to be transmitted.

2.8.3 Field mapping convention

When a field is contained within a single octet, the lowest bit number of the field represents the lowest order value.

When a field spans more than one octet, the order of bit values within each octet progressively decreases as the octet number increases. The lowest bit number associated with the field represents the lowest order value.

For example, a bit number can be identified as a couple (o, b) where o is the octet number and b is the relative bit number within the octet. Figure 3 illustrates a field that spans from bit (1, 3) to bit (2, 7). The high order bit of the field is mapped on bit (1, 3) and the low order bit is mapped on bit (2, 7).

An exception to the preceding field mapping convention is the data link layer FCS field, which spans two octets. In this case, bit 1 of the first octet is the high order bit and bit 8 of the second octet is the low order bit (see Figure 4).

0021 577

10/022,594

d) contains a frame check sequence error;

e) contains a single octet address field; or

f) contains a DLCI which is not supported by the receiver.

Invalid frames shall be discarded without notification to the sender. No action is taken as the result of invalid frames.

2.10 *Frame aborts*

The definition of and the reaction to frame aborts is as in Recommendation Q.921 [2].

3 Elements of procedures and formats of fields for data link layer peer-to-peer communication

3.1 *General*

The elements of procedures define the commands and responses that are used for peer-to-peer communication using the data link layer connections.

Procedures are derived from these elements of procedures and are described in § 5.

3.2 *Address field format*

The address field format shown in Figure 1/Q.922 contains the address field extension bits, a command/response indication, 3 bits reserved for forward and backward explicit congestion notification and discard eligibility (used with frame relaying services per Annex A), a data link connection identifier (DLCI) field and a bit to indicate whether the final octet of a 3 or 4 octet "address field" is lower DLCI or DL-CORE control (see § 3.3.7) information. The minimum and default length of the address field is 2 octets and it may be extended to 3 or 4 octets to support a larger DLCI address range or to support optional DL-CORE control functions. The 3-octet and 4-octet address field formats may be supported at the user-network interface or at the network-network interface based on negotiation or bilateral agreement.

The support of address fields longer than two octets is an option chosen by bilateral agreement. This option includes distinctions for supporting the address field length varying on an interface basis or on a per channel basis.

3.3 *Address field variables*

3.3.1 *Address field extension bit (EA)*

The address field range is extended by reserving the first transmitted bit of the address field octets to indicate the final octet of the address field. The presence, of a 0 in the first bit of an address field octet signals that another octet of the address field follows this one. The presence of a 1 in the first bit of an address field octet signals that it is the final octet of the address field. For example, the two octet address field has bit one of the first octet set to "0" and bit one of the second octet set to "1".

3.3.2 *Command/response field bit (C/R)*

The C/R bit identifies a frame as either a command or a response. When the frame to be sent is a command frame, the C/R bit shall be set to 0. When the frame to be sent is a response frame, the C/R bit shall be set to 1.

3.3.3 *Forward explicit congestion notification bit (FECN)*

This bit is reserved for use with frame relaying service, as described in Annex A and Appendix I.

Q.922 § 3 (8 pages)

10/612,594

Default address field format (2 octets)

<table>
<tr><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th></tr>
<tr><td colspan="6">Upper DLCI</td><td>C/R</td><td>EA
0</td></tr>
<tr><td colspan="4">Lower DLCI</td><td>FECN
(Note)</td><td>BECN
(Note)</td><td>DE
(Note)</td><td>EA
1</td></tr>
</table>

or

3 octets address field format

<table>
<tr><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th></tr>
<tr><td colspan="6">Upper DLCI</td><td>C/R</td><td>EA
0</td></tr>
<tr><td colspan="4">DLCI</td><td>FECN
(Note)</td><td>BECN
(Note)</td><td>DE
(Note)</td><td>EA
0</td></tr>
<tr><td colspan="6">Lower DLCI or
DL-CORE control</td><td>D/C</td><td>EA
1</td></tr>
</table>

or

4 octets address field format

<table>
<tr><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th></tr>
<tr><td colspan="6">Upper DLCI</td><td>C/R</td><td>EA
0</td></tr>
<tr><td colspan="4">DLCI</td><td>FECN
(Note)</td><td>BECN
(Note)</td><td>DE
(Note)</td><td>EA
0</td></tr>
<tr><td colspan="7">DLCI</td><td>EA
0</td></tr>
<tr><td colspan="6">Lower DLCI or
DL-CORE control</td><td>D/C</td><td>EA
1</td></tr>
</table>

EA	Address field extension bit
C/R	Command response bit
FECN	Forward explicit congestion notification
BECN	Backward explicit congestion notification
DLCI	Data link connection identifier
DE	Discard eligibility indicator
D/C	DLCI or DL-CORE control indicator

Note — See Annex A and Appendix I for the use of these 3 bits whiche are reserved for congestion notification signalling with frame relaying.

FIGURE 1/Q.922

Address field formats

10/022,594

3.3.4 *Backward explicit congestion notification bit (BECN)*

This bit is reserved for use with frame relaying service, as described in Annex A and Appendix I.

3.3.5 *Discard eligibility indicator (DE)*

This bit is reserved for use with frame relaying service, as described in Annex A and Appepndix I.

3.3.6 *Data link connection identifier (DLCI)*

The DLCI identifies a virtual connection on a bearer channel (i.e. D, B or H) at a user to network or network to network interface. Consequently, a DLCI specifies a data link layer entity to/from which information is delivered/received and which is to be carried in frames by data link layer entities. The DLCI field may be either unstructured or structured. In the former case, the least significant bit is determined as follows:

Address field size	D/C = 0	D/C = 1
2 octets	(Note)	(Note)
3 octets	bit 3 of octet 3	bit 5 of octet 2
4 octets	bit 3 of octet 4	bit 2 of octet 3

Note – Not applicable; least significant DLCI bit is bit 5 of octet 2.

A structure to the DLCI field may be established by the network at the user to network interface or at a network to network interface subject to negotiation or bilateral agreement.

For notation purposes, the 6 most significant bits (bits 8 to 3) in the first octet of the address field (which correspond to the SAPI field in Recommendation Q.921 [2]) are referred to as the upper DLCI.

Table 1/Q.922 shows the ranges of DLCI values which apply for specific functions to ensure compatibility with operation on a D-channel, which also may use the Q.921 [2] protocol. A two octet address field format for this Recommendation is assumed when used on a D-channel. For further study is whether 3 or 4 octet address field formats may be used on a D-channel.

3.3.7 *DLCI/DL-CORE control indicator (D/C)*

The D/C indicates whether the remaining six usable bits of that octet are to be interpreted as the lower DLCI bits or as DL-CORE control bits. The bit is set to 0 to indicate that the octet contains DLCI information. This bit is set to 1 to indicate that the octet contains DL-CORE control information. This indicator is limited to use in the last octet of the three or four octet type "address field". The use of this indication for DL-CORE control is reserved as there have not been any additional control functions defined which need to be carried in the "address field"; this indicator has been added to provide for possible future expansion of the protocol.

Note – The optional DL-CORE control field is part of the address field and therefore must not be confused with the control field of an HDLC frame as defined in Figure 1/Q.921.

3.4 *Control field formats*

The control field identifies the type of frame, which will be either a command or response. The control will contain sequence numbers where applicable.

Three types of control field formats are specified: numbered information transfer (I format), supervisory fractions (S format), and unnumbered information transfers and control functions (U format). The control field formats are shown in Table 2/O.922.

10/022,594

TABLE 1/Q.922

Use of DLCIs

DLCI range	Function
10 bits DLCIs (Note 1)	
DLCI range	Function
0 (Note 2)	In channel signalling, if required
1-15	Reserved
16-511	Network option: on non-D-channels, available for support of user information
512-991	Logical link identification for support of user information (Note 6)
992-1007	Layer 2 management of frame mode bearer service
1008-1022	Reserved
1023 (Note 2)	In channel layer 2 management, if required
16 bits DLCIs (Note 3)	
DLCI range	Function
0 (Note 2)	In channel signalling, if required
1-1023	Reserved
1024-32 767	Network option: on non-D-channels, available for support of user information
32 768-63 487	Logical link identification for support of user information (Note 6)
63 488-64 511	Layer 2 management of frame mode bearer service
64 512-65 534	Reserved
65 535 (Note 2)	In channel layer 2 management, if required
17 bits DLCIs (Note 4)	
DLCI range	Function
0 (Note 2)	In channel signalling, if required
1-2047	Reserved
2048-65 535	Network option: on non-D-channels, available for support of user information
65 536-126 975	Logical link identification for support of user information (Note 6)
126 976-129 023	Layer 2 management of frame mode bearer service
129 024-131 070	Reserved
131 071 (Note 2)	In channel layer 2 management, if required
23 bits DLCIs (Note 5)	
DLCI range	Function
0 (Note 2)	In channel signalling, if required
1-131 071	Reserved
131 072-4 194 303	Network option: on non-D-channels, available for support of user information

Note 1 — These DLCIs apply when a 2 octet address field is used or when a 3 octet address field is used with D/C = 1.

Note 2 — Only available within non-D-channel.

Note 3 — These DLCIs apply for non-D-channels when a 3 octet address field is used with D/C = 0.

Note 4 — These DLCIs apply for non-D-channels when a 4 octet address field is used with D/C = 1.

Note 5 — These DLCIs apply for non-D-channels when a 4 octet address field is used with D/C = 0.

Note 6 — The use of semi-permanent frame mode connections may reduce the number of DLCIs available from this range.

5 : 4/8

10/022,594

TABLE 2/Q.922

Control field formats

Control field bits (modulo 128)	8	7	6	5	4	3	2	1	
I format	N(S)							0	Octet 4 (Note)
	N(R)							P/F	Octet 5
S format	X	X	X	X	Su	Su	0	1	Octet 4
	N(R)							P/F	Octet 5
U format	M	M	M	P/F	M	M	1	1	Octet 4

N(S) Transmitter send sequence number

N(R) Transmitter receive sequence number

P/F Poll bit when used as a command, final bit when used as a response

X Reserved and set to 0

Su Supervisory function bit

M Modifier function bit

Note — The identification of these octets is consistent whith a 2 octet address field.
The values will be increased by 1 for a 3 octet address field and by 2 for a 4 octet address field.

3.4.1 *Information transfer (I) format*

The I format shall be used to perform an information transfer between layer 3 entities. The functions of N(S), N(R) and P/F (defined in § 3.5 of Recommendation Q.921 [2]) are independent; that is, each I frame has a N(S) sequence number, and a N(R) sequence number which may or may not acknowledge additional I frames received by the data link layer entity, and a P/F bit that may be set to 0 or 1.

The use of N(S), N(R) and P/F is defined in § 5 of Recommendation Q.921 [2].

Note – This I format differs from that of LAPD because LAPF allows the use of the F-bit.

3.4.2 *Supervisory (S) format*

The use of the S format is the same as that specified in Recommendation Q.921 [2].

3.4.3 *Unnumbered (U) format*

The use of the U format is the same as that specified in Recommendation Q.921 [2].

3.5 *Control field parameters and associated state variables*

The various parameters associated with the control field formats are described in Recommendation Q.921 [2].

10/022,594

3.6 *Frame types*

3.6.1 *Commands and responses*

The following commands and responses are used by either the user or the network data link layer entities and are represented in Table 3/Q.922. Each data link connection shall support the full set of commands and responses for each application implemented. The frame types associated with each of the two applications are identified in Table 3/Q.922.

Frame types associated with an application not implemented shall be discarded and no action shall be taken as a result of that frame.

For purposes of the LAPF procedures in each application, those encodings not identified in Table 3/Q.922 are identified as undefined command and response fields. The actions to be taken are specified in § 5.8.5.

The commands and responses in Table 3/Q.922 are defined in §§ 3.6.2 to 3.6.12.

TABLE 3/Q.922

Commands and responses — modulo 128

Application	Format	Commands	Responses	Encoding							
				8	7	6	5	4	3	2	1
Unacknowledged and multiple frame acknowledged information transfer	I	I	I	N(S)							0
				N(R)							P/F
	S	RR	RR	0	0	0	0	0	0	0	1
				N(R)							P/F
		RNR	RNR	0	0	0	0	0	1	0	1
				N(R)							P/F
		REJ	REJ	0	0	0	0	1	0	0	1
				N(R)							P/F
	U	SABME		0	1	1	P	1	1	1	1
			DM	0	0	0	F	1	1	1	1
		UI		0	0	0	P	0	0	1	1
		DISC		0	1	0	P	0	0	1	1
			UA	0	1	1	F	0	0	1	1
			FRMR	1	0	0	F	0	1	1	1
Connection management (Note 1)	U	XID	XID	1	0	1	P/F	1	1	1	1

Note 1 — Congestion management is included in this row of the table.

Note 2 — Use of the SREJ frame is for further study.

53:48

10/022,594

3.6.2 *Information command/response*

The function of the information (I) frame is to transfer, across a data link connection, sequentially numbered frames containing information fields provided by layer 3. The I command is used in the multiple frame operation on a point-to-point data link. The I response may be received by the data link layer entity in the multiple frame operation on a point-to-point data link.

Note – This differs from LAPD by adding information response frames.

3.6.3 *Set asynchronous balanced mode extended (SABME) command*

The SABME unnumbered command is defined in Recommendation Q.921 [2].

3.6.4 *Disconnection (DISC) command*

The DISC unnumbered command is defined in Recommendation Q.921 [2].

3.6.5 *Unnumbered information (UI) command*

The UI unnumbered command is defined in Recommendation Q.921 [2].

3.6.6 *Receive ready (RR) command/response*

The RR supervisory frame is defined in Recommendation Q.921 [2].

3.6.7 *Reject (REJ) command/response*

The REJ supervisory frame is defined in Recommendation Q.921 [2].

3.6.8 *Receive not ready (RNR) command/response*

The RNR supervisory frame is defined in Recommendation Q.921 [2].

3.6.9 *Unnumbered acknowledgement (UA) response*

The UA unnumbered response is defined in Recommendation Q.921 [2].

3.6.10 *Disconnected mode (DM) response*

The DM unnumbered response is defined in Recommendation Q.921 [2].

3.6.11 *Frame reject (FRMR) response*

The FRMR unnumbered response may be sent or received by a data link layer entity as a report of an error condition not recoverable by retransmission of the identical frame, i.e., at least one of the following error conditions resulting from the receipt of a valid frame:

a) the receipt of a command or response control field that is undefined or not implemented;

b) the receipt of a supervisory frame or unnumbered frame with incorrect length;

c) the receipt of an invalid N(R); or

d) the receipt of a frame with an I field that exceeds the maximum established length.

An undefined control field is any of the control field encodings that are not identified in Table 3/Q.922.

A valid N(R) field is one that is in the range $V(A) \le N(R) \le V(S)$, where V(A) is the acknowledge state variable and V(S) is the send state variable (see §§ 3.5.2.2 and 3.5.2.3 of Recommendation Q.921 [2]).

The FRMR response frame information field is defined in Recommendation Q.921 [2].

5 : 7/8

10/022,594

3.6.12 *Exchange identification (XID) command/response*

The XID frame is defined in Recommendation Q.921 [2] for the connection management application. For the congestion management application, the XID frame is defined in Annex A.

4 Elements for layer-to-layer communication

4.1 *General*

Communications between layers and, for this Recommendation, between the data link layer and the layer management are accomplished by means of primitives.

Primitives represent, in an abstract way, the logical exchange of information and control between the data link and adjacent layers. They do not specify or constrain implementations.

An architectural model showing the relationships among the layers and sublayers of both the C-plane and the U-plane, together with their layer management entities and system management, is given in Figure 2/Q.922. In this model, a key component is the synchronization and convergence function (SCF) within the network layers of both the C-plane and the U-plane. This SCF coordinates connection establishment and release between the C-plane and the U-plane. The SCF and the U-plane layer 3 functions are outside the scope of this Recommendation.

An overview model, illustrating the flow of messages and service primitives, is provided in Figures 3/Q.922 through 6/Q.922. These figures provide more detailed flow information for the model illustrated in Figure 2/Q.922. For simplification of representation, the C-plane layer 3 functional block has been merged with the U-plane layer 3 functional block and with the SCF. Only the DL-SAP in the U-plane is shown; the DL-SAP in the C-plane in support of signalling is not illustrated.

Primitives consist of commands and their respective responses associated with the services requested of a lower or an upper layer. The general syntax of a primitive is:

XX – Generic name – Type: Parameters

where XX designates the interface across which t he primitive flows. For this Recommendation, XX is:

- DL-CORE for communications between the DL-CORE user and the DL-CORE (discribed in § A.4);
- DL for communications between layer 3 and the data link layer;
- PH for communications between the data link layer and the physical layer;
- MC for communication between the DL-CORE and layer 2 management (described in § A.4);
- MDL for communications between the layer 2 management and the data link layer; or
- M2N for communications between the layer 3 and layer 2 management entities.

A general representation of primitive interactions with frame types within the U-plane and layer 3 messages within the C-plane is described in Figures 3/Q.922 through 6/Q.922.

The U-plane layer 2 functional block supports the layer 2 protocol procedures in accordance with this Recommendation. Layer 2 U-plane services are provided at DL-SAP and may be invoked by the service user by means of DL-primitives.

The layer 3 functional block includes the functionality for call control within the C-plane (Q.933 [3] call control procedures), the layer 3 U-plane functionality and the functions to perform coordination between C- and U-plane layer 3 entities.

3 : 8/8

10/022,534

ANNEX A

(to Recommendation Q.922)

Core aspects of Q.922 for use with frame relaying bearer service

A.1 *General*

This annex describes the core aspects of Q.922 for use with the frame relaying bearer service by identifying the differences between the main text of this Recommendation and the structure necessary to support a frame relaying protocol.

This annex contains the frame structure, elements of procedure, format the fields and procedures for the proper operation of the frame relaying FMBS layer 2 protocol as described in Recommendation I.122 [11] and service description Recommendation I.233 [1]. The core aspects of Q.922 provide for transparent transfer of DL-CORE service user data.

Note – The core aspects of Q.922 as defined in this annex may be used with or without the elements of procedures of LAPF.

This protocol is a subset of LAPF. It is intended to:

- share the core functions of LAPF as defined in Recommendation I.233 [1];
- be used on any ISDN channel; and
- operate on the D-channel concurrently with the LAPD protocol as defined in Recommendation Q.921 [2].

It assumes that data link identification is determined via group signalling or by prior agreement. Group signalling is defined in Appendix II.

The core functions of LAPF used to support the frame relaying bearer service are considered to be:

- frame delimiting, alignment and transparency,
- frame multiplexing/demultiplexing using the address field;
- inspection of the frame to ensure that it consists of an integral number of octets prior to zero bit insertion of following zero bit extraction;
- inspection of the frame to ensure that it is neither too long nor too short;
- detection of (but not recovery from) transmission errors; and
- congestion control functions.

A.2 *Frame structure for peer-to-peer communication*

A.2.1 *General*

All data link layer peer-to-peer exchanges are in frames conforming to the format shown in Figure A-1/Q.922.

A.2.2 *Flag sequence*

See § 2.2.

A.2.3 *Address field*

The address field shall consist of at least two octets, as illustrated in Figure A-1/Q.922 but may optionally be extended up to 4 octets. The format of the address field is defined in § A.3.2.

Q 922 Annex A (19 pages)

10/022,994

8	7	6	5	4	3	2	1	
Flag								
0	1	1	1	1	1	1	0	Octet 1
High order octet of address field						(Note)		2
Low order octet of address field								3
								4
Frame relay information field								
								N-3
Frame check sequence (FCS) 1st octet								N-2
Frame check sequence (FCS) 2nd octet								N-1
Flag								
0	1	1	1	1	1	1	0	N

Note – The default address field length is 2 octets. It may be extended to either 3 or 4 octets bilateral agreement.

FIGURE A-1/Q922

Frame relay frame format with two octet address

A.2.4 *Control field*

A control field, as seen by the DL-CORE Sublayer, does not exist in a frame relay frame structure.

A.2.5 *Frame relaying information field*

The frame relaying information field of a frame, when present, follows the address field (see § A.3.2) and precedes the frame check sequence field (see § A.2.7). The contents of the frame relaying information field shall consist of an integral number of octets.

The maximum number of octets in the frame relaying information field is defined in § A.5.1.

A.2.6 *Transparency*

A transmitting data link layer entity shall examine the frame content between the opening and closing flag sequences, (address, information and FCS fields) and shall insert a "0" bit after all sequences of five contiguous "1" bits (including the last five bits of the FCS) to ensure that a flag or an abort sequence is not simulated within the frame. A receiving data link layer entity shall examine the frame contents between the opening and closing flag sequences and shall discard any "0" bit which directly follows five contiguous "1" bits.

A.2.7 *Frame checking sequence (FCS) field*

The definition and use of the FCS is as described in § 2.7.

10/022,594

A.2.8 *Format convention*

The definitions of formats and numbering conventions are as describe in § 2.8.

A.2.9 *Invalid frames*

The definition of invalid frames is as described in § 2.9.

If a frame which is too long is received by the network, the network may:

- discard the frame (see Note);
- send part of the frame toward the destination user, then abort the frame; or
- send the complete frame toward the destination user with a valid FCS.

Note – This approach implies that the implementation of the Q.922 protocol can not exploit the capabilities to discriminate among corrupted or too long frames.

Selection of one or more of these behaviors is an option for designers of frame relay network equipment and is not subject to further standardization. Users shall not make any assumption as to which of these actions the network will take. In addition, the network may optionally clear the frame relay call if the number or frequency of too-long frames exceeds a network specified threshold.

A.2.10 *Frame abort*

The definition of and reaction to a frame abort is discussed in § 2.10.

A.3 *Elements of procedures and formats of fields for the DL-CORE service sublayer*

A.3.1 *General*

The elements of procedures contained in this annex are used by the DL-CORE service sublayer to implement optional procedures for congestion management which are found in § A.6.

A.3.2 *Address field format*

The format of the address field is shown in Figure A-2/Q.922. This field includes the address field extension bits, a bit reserved for use by end user equipment intended to support a command/response indication, forward and backward congestion notification bits, discard eligibility indication, an indicator for DLCI or DL-CORE control interpretation of a 3 or 4 octet "address field" and a data link identification (DLCI) field. The minimum and default length of the address field is 2 octets and it may be extended to 3 or 4 octets to support a larger DLCI address range or to support the optional DL-CORE control functions. The 3-octet or 4-octet address field formats may be supported at the user-network interface or the network-network interface based on bilateral agreement.

A.3.3 *Address field variables*

A.3.3.1 *Address field extension bit (EA)*

The definition and use of the EA bit is discussed in § 3.3.1.

A.3.3.2 *Command/response bit C/R*

The C/R bit is not used by the DL-CORE protocol. The coding is application specific. The C/R bit is conveyed transparently by the DL-CORE protocol between DL-CORE services users.

A.3.3.3 *Forward explicit congestion notification (FECN)*

This bit may be set by a congested network to notify the user that congestion avoidance procedures should be initiated where applicable for traffic in the direction of the frame carrying the FECN indication. This bit is set to 1 to indicate to the receiving end-system that the frames it receives have encountered congested resources. This bit may be used by destination controlled transmitter rate adjustment.

10/022,594

Default address field format (2 Bytes)

8	7	6	5	4	3	2	1
Upper DLCI						*	EA 0
Lower DLCI				FECN	BECN	DE	EA 1

or

3 octet address field format

8	7	6	5	4	3	2	1
Upper DLCI						*	EA 0
DLCI				FECN	BECN	DE	EA 0
Lower DLCI or DL-CORE control						D/C	EA 1

or

4 octet address field format

8	7	6	5	4	3	2	1
Upper DLCI						*	EA 0
DLCI				FECN	BECN	DE	EA 0
DLCI							EA 0
Lower DLCI or DL-CORE control						D/C	EA 1

D/C DLCI or DL-CORE control indicator (see § A.3.3.7)
DE Discard eligibility indicator (see § A.3.3.5)
EA Address field extension bit (see § A.3.3.1)
* Bit intended to support a command/response indication. The coding is application specific (see § A.3.3.2)
FECN Forward explicit congestion notification (see § A.3.3.3)
BECN Backward explicit congestion notification (see § A.3.3.4)
DLCI Data link connection identifier (see § A.3.3.6)

FIGURE A-2/Q.922

Address field formats

10/022,994

While setting this bit by the network or user is optional, no network shall ever clear (set to 0) this bit. Networks that do not provide FECN shall pass this bit unchanged. An example of the use of this bit is contained in Appendix I.

A.3.3.4 *Backward explicit congestion notification (BECN)*

This bit may be set by a congested network to notify the user that congestion avoidance procedures should be initiated, where applicable for traffic in the opposite direction of the frame carrying the BECN indicator. This bit is set to 1 to indicate to the receiving end-system that the frames it transmits may encounter congested resources. This bit may be used by source controlled transmitter rate adjustment.

While setting this bit by the network or user is optional, no network shall ever clear (set to 0) this bit. Networks that do not provide BECN shall pass this bit unchanged. An example of the use of this bit is contained in Appendix I.

A.3.3.5 *Discard eligibility indicator (DE)*

This bit, if used, is set to 1 to indicate a request that a frame should be discarded in preference to other frames in a congestion situation. Setting of this bit by the network or user is optional. No network shall ever clear (set to 0) this bit. Networks that do not provide DE shall pass this bit unchanged. Networks are not constrained to discard only frames with DE = 1 in the presence of congestion.

A.3.3.6 *Data link connection identifier (DLCI)*

The DLCI has a default length of 10 bits. The extension bit may be used to optionally increase the length to 16, 17 or 23 bits, as shown in Figure A-2/Q.922. The ranges for the DLCI values are shown in Table 1/Q.922. As discussed in § 3.3.7, the D/C indication may affect the length of the DLCI.

A.3.3.7 *DLCI/DL-CORE control indicator (D/C)*

The definition and use of D/C are discussed in § 3.3.7.

A.4 *Placement of the DL-CORE protocol in the ISDN protocol architecture*

This section describes the placement of the DL-CORE protocol in the context of a layered architecture. The concepts of the OSI reference model (see Recommendation X.200 [12]), the OSI service conventions (see Recommendation X.210 [13]), and the ISDN protocol reference model (see Recommendation I.320 [14]) are used. The definition of layer to layer communication and a general introduction to the functional model is given in § 4. For this annex, a representative model is presented also for the sublayer communication with the DL-CORE Sublayer.

The Figures A-3/Q.922 and A-4/Q.922 depict the model which represents primitive interactions with messages for the support of the core service according to Recommandation I.233 [1].

The U-plane layer 2 is subdivided into:

a) a DL-CONTROL Sublayer; and

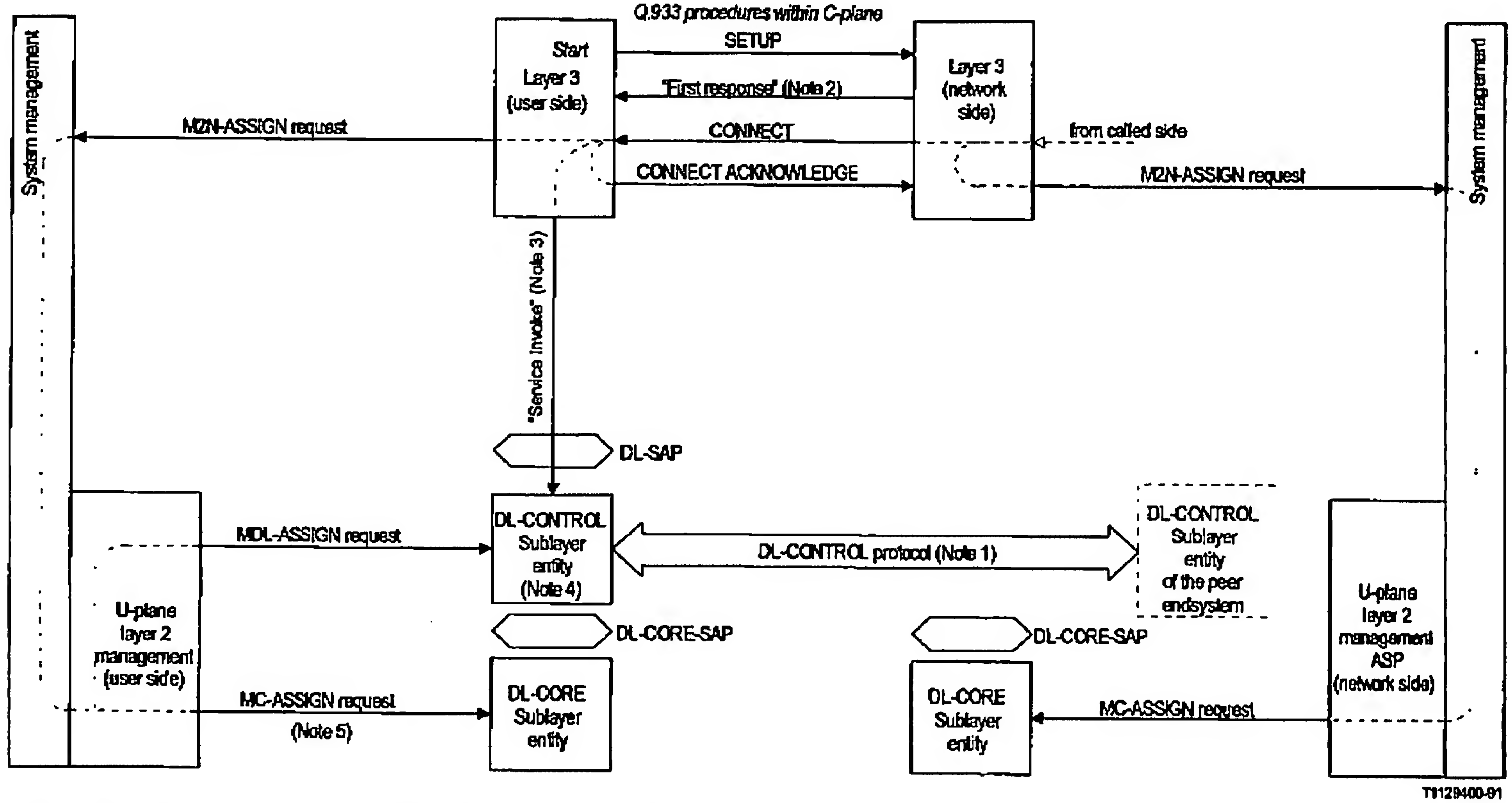
b) a DL-CORE Sublayer.

The DL-CORE Sublayer provides core services to the user, a DL-CONTROL Sublayer, at the DL-CORE-SAP.

The model shown in the figures covers both frame relaying and frame switching. In the case of frame relaying, the DL-CONTROL Sublayer entities at the network side are not present.

The signal flows are based upon those shown in Figures 3/Q.922 through 6/Q.922. Figure A-3/Q.922 depicts the signal flows at the calling access and called access interfaces. Figure A-4/Q.922 depicts the signal flows at the releasing access and released access interfaces.

10/022,544



Note 1 – The DL-CONTROL protocol may be a Q.922 protocol procedure, another CCITT specified protocol, or any protocol between endsystems which, as a DL-CORE service user, is compatible with the DL-CORE sublayer services.

Note 2 – The reserved DLCI is indicated in the first response to the SETUP message, e.g., CALL PROCEEDING.

Note 3 – The "service invoke" is not further defined in this Recommendation since it depends on the service provided by the DL-CONTROL Sublayer.

Note 4 – For frame relaying, this DL-CONTROL Sublayer entity established the U-plane Layer 2 connection between the two endsystems. Since there is no DL-CONTROL Sublayer entity present at the network side (calling side), no collision is enforced between the U-plane Layer 2 PDUs, if any, establishing the U-plane link.

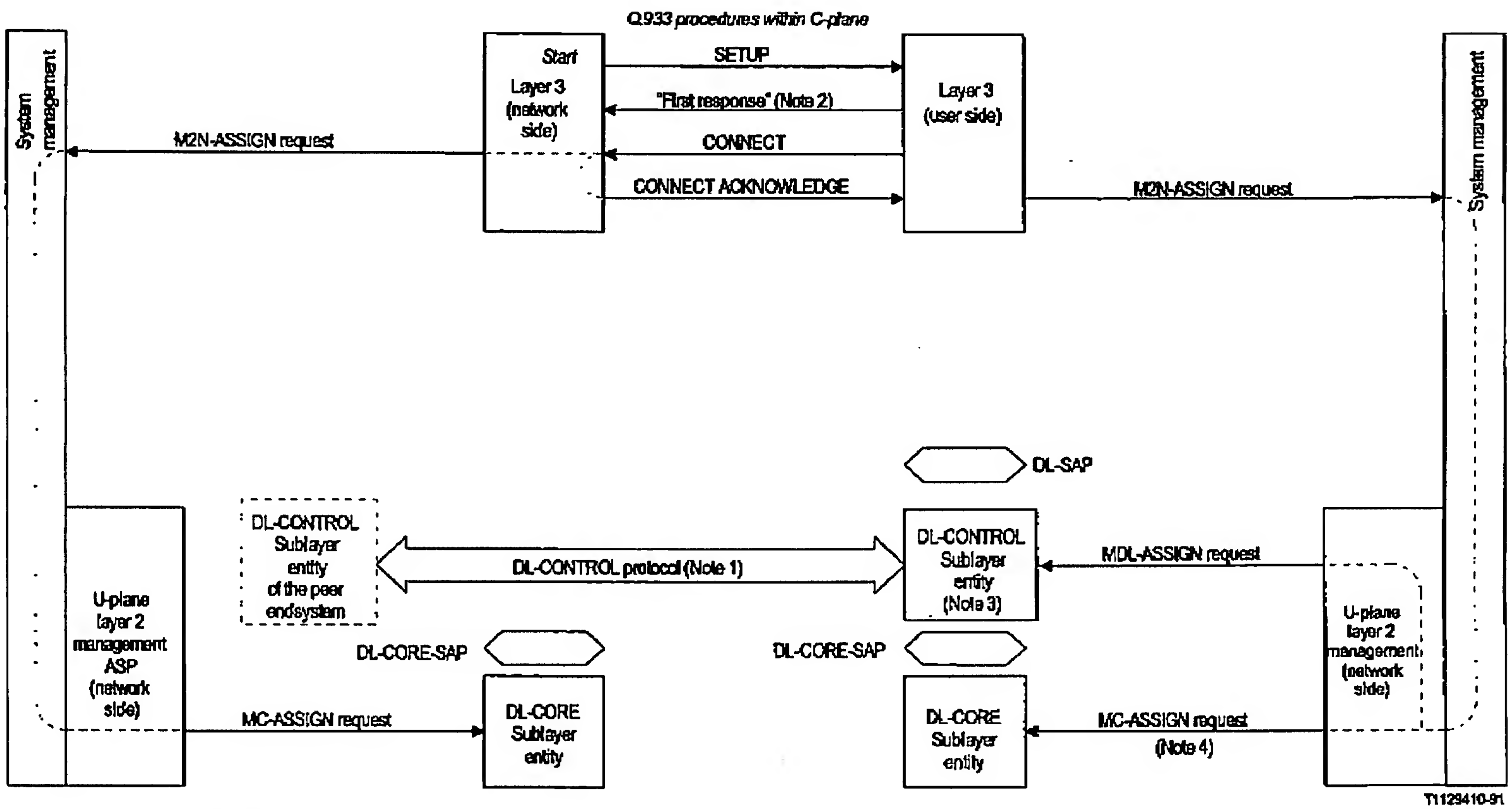
Note 5 – This reflects the case when the MC-ASSIGN request is received prior to the DL-CORE DATA request; otherwise, an MC-ASSIGN indication would be issued to acquire a DLCI.

FIGURE A-3/Q.922 (sheet 1 of 2)

Relationship of primitives with messages for core services connection establishment

6/19

10/022,894



Note 1 – The DL-CONTROL protocol may be a Q.922 protocol procedure, another CCITT specified protocol, or any protocol between endsystems which, as a DL-CORE service user, is compatible with the DL-CORE sublayer services.

Note 2 – The reserved DLCI is indicated in the first response to the SETUP message, e.g., CALL PROCEEDING.

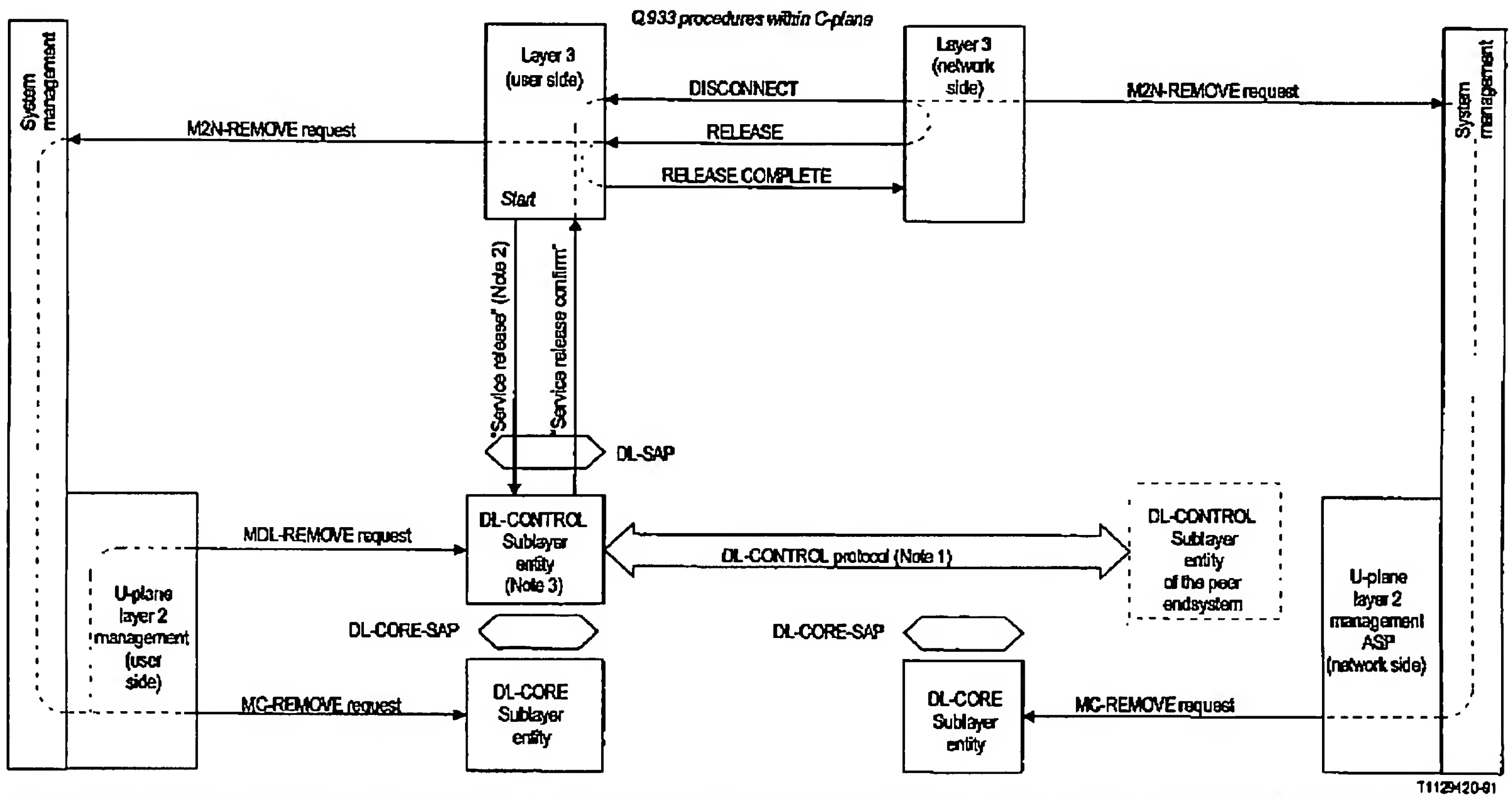
Note 3 – For frame relaying, this DL-CONTROL Sublayer entity established the U-plane Layer 2 connection between the two endsystems. Since there is no DL-CONTROL Sublayer present at the network side (calling side), no collision is enforced between the U-plane Layer 2 PDUs, if any, establishing the U-plane link.

Note 4 – This reflects the case when the MC-ASSIGN request is received prior to the DL-CORE DATA request; otherwise, an MC-ASSIGN indication would be issued to acquire a DLCI.

FIGURE A-3/Q.922 (sheet 2 of 2)

Relationship of primitives with messages for core services connection establishment

7/19



Note 1 – The DL-CONTROL protocol may be a Q.922 protocol procedure, another CCITT specified protocol, or any protocol between endsystems which, as a DL-CORE service user, is compatible with the DL-CORE sublayer services.

Note 2 – The "service release" is not further defined in this Recommendation since it depends upon the service provided by the DL-CONTROL Sublayer. The "service release confirm" is required to avoid premature release of the connection within the C-plane.

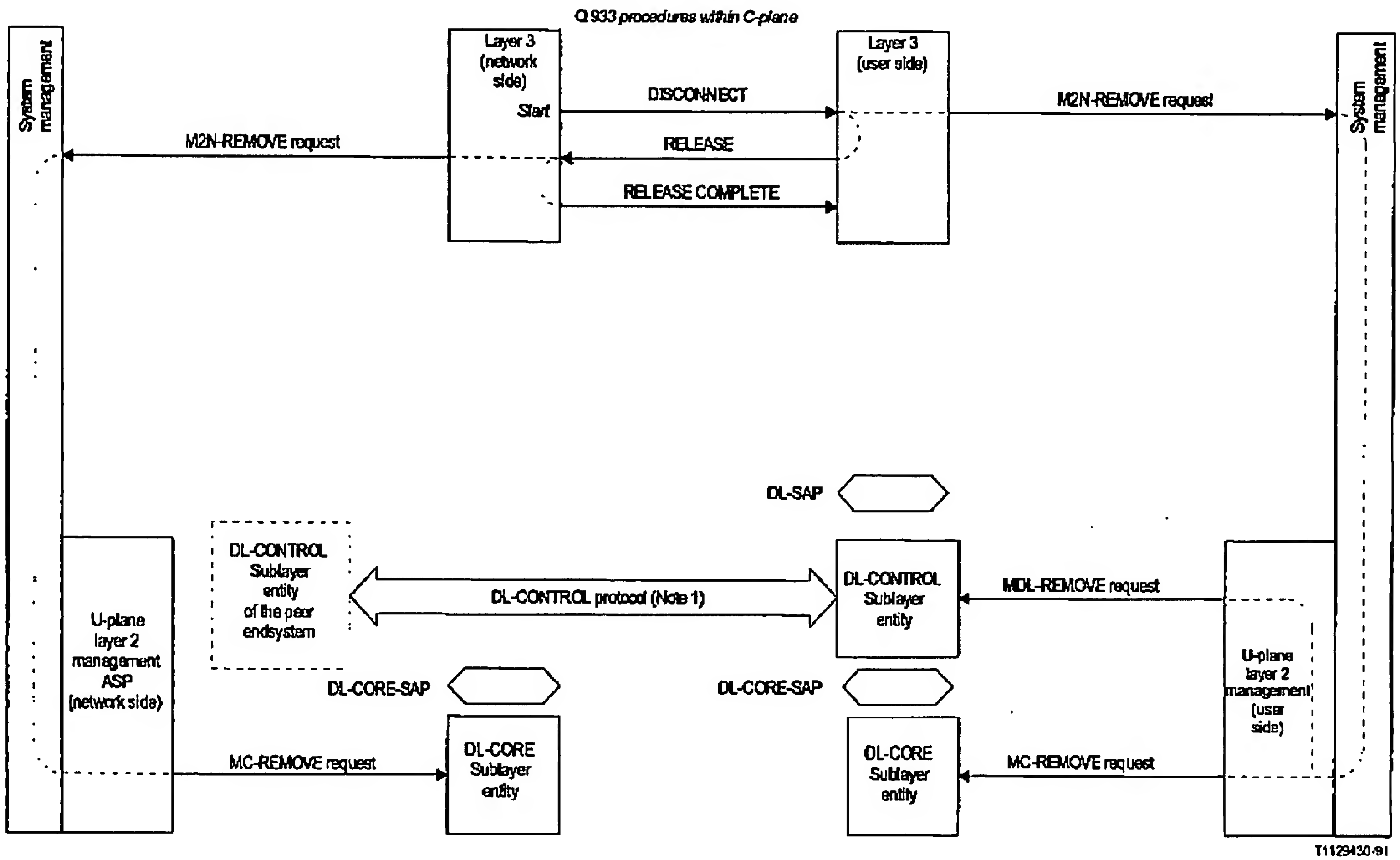
Note 3 – For frame relaying, this DL-CONTROL Sublayer entity releases the U-plane Layer 2 connection between the two endsystems. Since there is no DL-CONTROL Sublayer entity present at the network side (released side), no collision is enforced between the U-plane Layer 2 PDUs, if any, releasing the U-plane link.

FIGURE A-4/Q.922 (sheet 1 of 2)

Relationship of primitives with messages for core services connection establishment

·7423594

10/022,594



Note 1 – The DL-CONTROL protocol may be a Q.922 protocol procedure, another CCITT specified protocol, or any protocol between endsystems which, as a DL-CORE service user, is compatible with the DL-CORE sublayer services.

FIGURE A-4/Q.922 (sheet 2 of 2)

Relationship of primitives with messages for core services connection establishment

A : 9/19

10/022,594

Table A-1/Q.922 illustrates the primitives defined for the core aspects of LAPF.

TABLE A-1/Q.922

Primitive types

Generic name	Type				Parameter		Message unit contents
	Request	Indication	Response	Confirmation	Priority indicator	Message unit	
Layer 3 — Layer 2 management							
M2N-ASSIGN	X	—	—	—	—	X	DL-CEI, DLCI (Note 1)
M2N-REMOVE	X	—	—	—	—	X	DLCI
DL-Core user — DL-Core							
DL-CORE-DATA	X	X	—	—	—	X	See § A.4.2.2
DL-CONTROL — Layer 2 management							
MDL-ASSIGN	X	—	—	—	—	X	DL-CORE CEI, DL-CEI
MDL-REMOVE	X	—	—	—	—	X	DL-CORE CEI
DL-Core — Layer 2 management							
MC-ASSIGN	X	X	—	—	—	X	DLCI, DL-CORE CEI
MC-REMOVE	X	—	—	—	—	X	DLCI
Layer 2 — Layer 1							
PH-DATA	X	X	—	—	X (Note 2)	X	Data link layer peer-to-peer message

Note 1 — Optional parameters; if missing, default values art used or procedures of Appendix III are used.

Note 2 — A priority indicator for layer 1 is not present in Recommendation X.211 [9] and is used only for the basic rate interface D-channel. Recommendation X.211 [9] does not consider priority as a layer 1 quality of service parameter.

A.4.1 *Support by the underlying physical layer service*

The physical layer service is defined in the OSI physical layer service definition (see Recommendation X.211 [9]). Only duplex (two-way simultaneous), point-to-point synchronous transmission is used. The optional PH-Connection activation and deactivation services of the physical layer are not presently used to support the DL-CORE protocol.

A.4.2 *DL-CORE service*

Recommendation I.233 [1] provides a layer service description for the DL-CORE Sublayer. The DL-CORE protocol is used to provide and support this layer service.

A.4.2.1 *Primitives*

The DL-CORE DATA primitives are described in Annex B of Recommendation I.233 [1].

10/022,594

A.4.2.2 *Parameters*

The parameters associated with the DL-CORE DATA primitives are defined in Annex C of Recommendation I.233 [1]. The mapping of these core services parameters to DL-CORE-PDU fields is as follows:

Core service parameter (defined in Recommendation I.233 [1])	DL-CORE DATA primitive		DL-CORE-PDU field
	Request	Indication	
DL-CORE user data	X	X	Information field
Discard eligibility	X		Discard eligibility
Congestion encountered backward		X	BECN
Congestion encountered forward		X	FECN
DL-CORE service user protocol control information	X	X	C/R bit

A.4.2.3 *Procedures*

A.4.2.3.1 *Primitives/Frame relay frame mappings*

When a DL-CORE entity receives a DL-CORE DATA request from the DL-CORE service user, it sends a frame relay frame to its peer.

When a DL-CORE entity receives a valid frame relay frame, it signals a DL-CORE DATA indication to the DL-CORE service user.

A.4.2.3.2 *Parameters/fields mappings*

The parameters to the DL-CORE DATA request and DL-CORE DATA indication primitives are directly mapped to the fields of the frame relay frame as shown in § A.4.2.2.

A.4.3 *Layer management*

Table A-1/Q.922 shows the primitives exchanged between the DL-CORE Sublayer management entity and the DL-CORE Sublayer entity.

A.4.3.1 *Primitives*

A.4.3.1.1 *MC-ASSIGN request*

The MC-ASSIGN request primitive is used by the layer management entity to:

- signal to the DL-CORE Sublayer entity that a DL-CORE Connection has been established,
- convey the DLCI agreed to be used between DL-CORE entities in support of that Core-connection,
- convey the associated DL-CORE Connection Endpoint Identifier to be used uniquely identify the DL-CORE Connection and
- convey the Connection Endpoint Identifier used to support the DL-CORE Connection.

10/022,594

A.4.3.1.2 *MC-REMOVE request*

The MC-REMOVE request primitive is used by the layer management entity to signal to the DL-CORE Sublayer entity that a DLCI has been released.

A.4.3.1.3 *M2N-ASSIGN*

The M2N-ASSIGN primitives are defined in § 4.1.1.10.

A.4.3.1.4 *M2N-REMOVE*

The M2N-REMOVE primitives are defined in § 4.1.1.11.

A.4.3.1.5 *MDL-ASSIGN request*

The MDL-ASSIGN request establishes a mapping in the DL-CONTROL Sublayer entity between the DL-CORE CEI and the DL-CEI.

A.4.3.1.6 *MDL-REMOVE request*

The MDL-REMOVE request primitive is used by the layer 2 management entity to remove a mapping between a DL-CEI and a DL-CORE CEI.

A.4.3.2 *Parameters*

A.4.3.2.1 *DLCI value*

The DLCI value parameter conveys the DLCI agreed to be used between DL-CORE Entities in support of a DL-CORE Connection. Its syntax and usage by the protocol are defined in § 3.6.

A.4.3.2.2 *DL-CORE Connection Endpoint Identifier*

The DL-CORE CEI uniquely identifies a DL-CORE Connection. It is defined in Recommendation I.233 [1].

A.4.3.2.3 *DL-Connection Endpoint Identifier*

The DL-CEI uniquely identifies a DL-Connection.

A.4.3.2.4 *Physical Connection Endpoint Identifier*

The physical Connection Endpoint Identifier uniquely identifies a physical Connection to be used in support of a DL-CORE Connection.

A.4.3.3 *Procedures*

For permanent frame relay bearer connections, information related to the operation of the DL-CORE protocol in support of DL-CORE Connections is maintained by DL-CORE Sublayer management. For demand frame relay bearer connections, the layer 3 establishes and releases DL-CORE Connections on behalf of the DL-CORE Sublayer. Therefore, information related to the operation of the DL-CORE protocol is maintained by coordination of layer 3 management and DL-CORE Sublayer management through the operation of the local systems environment.

10/022,594

A.4.3.3.1 *DL-CORE connection establishment*

When it is necessary to notify the DL-CORE Sublayer entity (either because of establishment of a demand frame relay call, because of notification of re-establishment of a permanent frame relay bearer connection or because of system initialization) that a DL-CORE Connection is to be established, the DL-CORE Layer management entity signals an MC-ASSIGN request primitive to the DL-CORE Sublayer entity. In addition, the Layer 2 management entity initiates an MDL-ASSIGN request to the DL-CONTROL Sublayer entity.

The DL-CORE Sublayer entity establishes the necessary mappings between the supporting physical Connection, the DL-CORE CEI and the DLCI. In addition, if it has not already done so, it begins to transmit flags on the physical Connection.

The DL-CONTROL Sublayer entity establishes the necessary mappings between the DL-CORE CEI and the DL-CEI.

A.4.3.3.2 *DL-CORE connection release*

When it is necessary to notify the DL-CORE Sublayer entity (either because of release of a demand frame relay call or because of notification of failure of a permanent frame relay bearer connection) that a DL-CORE Connection is to be released the DL-CORE Layer management entity signals an MC-REMOVE request primitive to the DL-CORE Sublayer entity, and an MDL-REMOVE request to the DL-CONTROL Sublayer entity.

The DL-CORE Sublayer entity removes any mappings between the supporting physical Connection, the DL-CORE CEI and the DLCI.

The DL-CONTROL Sublayer entity removes any mapping between the DL-CORE CEI and the DL-CEI.

A.5 *List of system parameters*

The system parameters listed below are associated with each individual frame relaying connection.

A.5.1 *Maximum number of octets in a frame relaying information field (N203)*

The default for the maximum number of octets in a frame relaying information field is 262 octets (i.e. N201 + 2). The minimum frame relaying information field size is one octet. The default maximum size was chosen for compatible operation with LAPD on the D-channel, which has a 2 octet control field and a 260 octet maximum information field. All other maximum values are negotiated (e.g. using Q.933 procedures) between users and networks and between networks. The support by networks of a negotiated maximum value of at least 1600 octets is strongly recommended for applications such as LAN interconnection to minimize the need for segmentation and reassembly by the user equipment.

A.6 *Congestion control procedures*

Congestion in the user plane occurs when traffic arriving at a resource exceeds the network's capacity. It can also occur for other reasons (e.g. equipment failure). Network congestion affects the throughput rate, delay and frame loss experienced by the end user.

End users should reduce, their offered load in the face of network congestion. Reduction of offered load by an end user may well result in an increase in the effective throughput available to the end user during congestion.

10/022,594

Congestion control may be achieved by:

i) congestion avoidance mechanisms, and/or

ii) congestion recovery mechanisms.

Congestion avoidance (see Note) mechanisms, as discussed in §§ A.6.2 and A.7, are used at the onset of congestion to minimize its negative effect on the network and the user.

Note – Congestion avoidance, as defined in Recommendtion I.370 [10], is intended to minimize degradation in the quality of service. The specification of the degree of degradation is beyond the scope of this Recommendation.

Congestion recovery mechanisms, as defined in § A.6.1, are used to prevent network collapse in the face of severe congestion.

Congestion avoidance and congestion recovery are effective and complementary forms of congestion control in frame relaying networks.

A.6.1 *Implicit congestion detection*

For implicit congestion detection schemes, the frame relaying network does not send an indication to the user. Implicit congestion schemes involve certain events available in the layer 2 elements of procedures to detect the frame loss (e.g. receipt of a REJECT frame, timer recovery, etc.).

The intent of this scheme is to reduce the offered load to the network by the end user. Use of such reduction by users is optional. An example of one approach is discussed in § I.1.

A.6.2 *Explicit notification*

Explicit notification is a procedure used for congestion avoidance. Explicit notification is a part of the data transfer phase protocol. Users should react to explicit congestion notification (i.e. the reaction is a highly desirable option). Users that are not able to act on explicit congestion notification shall have the capability to receive and ignore explicit notification generated by the network.

Reaction by the end user to the receipt of explicit congestion notification is rate based.

A.6.2.1 *Explicit congestion signals*

Explicit congestion signals are sent in both forward (towards frame destination) and backward (towards frame source) directions. Forward explicit congestion notification is provided by using the FECN bit in the address field. Backward explicit congestion notification is provided by one of two methods. When timely reverse traffic is available, the BECN bit in an appropriate address field may be used. Otherwise, a single consolidated link layer management message may be generated by the network (see § A.7). The Consolidated link layer management (CLLM) message travels on the U-plane physical path. The generation and transport of CLLM by the network is optional.

All networks must transport the FECN and BECN bits without resetting.

A.6.2.2 *Rate reduction strategy*

The specific rate reduction strategy to be used by end users is not identified. An example is discussed in § I.2.

A.7 *Consolidated link layer management (CLLM) message*

The consolidated link layer management message is based on ISO 8885 [15] definition of the use of XID frames for the transport of functional information. The generation and transport of the CLLM are optional. Figures A-5/Q.922 and A-6/Q.922 illustrate the format of this frame. Each parameter is described using the sequence type – length – value. The following subsections describe the functional fields for the consolidated link layer management message. All fields are binary encoded unless otherwise specified.

10/022,594

Octet	Bits 87654321	Field name
1	111110R0	Address octet 1 (R indicates "response")
2	11110001	Address octet 2
3	10101111	XID control field
4	10000010	Format identifier (130)
5	00001111	Group identifier = 15 (Private parameters negotiation)
6		Group length octet 1
7		Group length octet 2
8	00000000	Parameter identifier = 0 (Parameter set identification)
9	00000100	Parameter length (4)
10	01101001	Parameter value = 105 (IA5 coded I)
11	00110001	Parameter value = 49 (IA5 coded 1)
12	00110010	Parameter value = 50 (IA5 coded 2)
13	00110010	Parameter value = 50 (IA5 coded 2)
14	00000010	Parameter identifier = 2 (cause id)
15	00000001	Parameter length = 1
16		Cause value
17	00000011	Parameter value = 3 (DLCI identifier)
18		Parameter length
19		DLCI value octet 1
20		DLCI value octet 2
//		//
2n + 17		DLCI value octet (n-th DLCI)
2n + 18		DLCI value octet (n-th DLCI)
2n + 19		FCS octet 1
2n + 20		FCS octet 2

FIGURE A-5/Q.922

Consolidated link layer management message (B- or H-channel) using 2 octet address field

10/022,594

Octet	Bits 8 7 6 5 4 3 2 1	Field name
1	1 1 1 1 1 0 R 0	Address octet 1 (SAPI = 62) (R indicates "response")
2	1 1 1 1 1 1 1 1	Address octet 2 (TEI = 127)
3	1 0 1 0 1 1 1 1	XID control field
4	1 0 0 0 0 0 1 0	Format identifier (130)
5	0 0 0 0 1 1 1 1	Group ident. = 15 (Private parameters negotiation)
		Octet 6 to 2n + 18 as for B- or H-channels in Figure A-5/Q.922
	//	//
2n + 19		FCS octet 1
2n + 20		FCS octet 2

FIGURE A-6/Q.922

Consolidated link layer management message (D-channel) using 2 octet address field

A.7.1 *Address octets*

The default address size of two octets is used in the following specification.

Note – The use of CLLM for 3 or 4 octet address fields is for further study.

Octets 1 and 2 represent the address field for a default two octet address. The first octet includes the 6 bit upper DLCI subfield. The second octet includes the 4 bit lower DLCI subfield.

The CLLM message is sent in an XID-response frame. Except when delivered on a D-channel, it is sent in the management DLCI as shown in Figure A-5/Q.922. The congestion indication bits and the discard eligibility indicator are not used in this case and should be set to "0". When delivered on the D-channel, it is sent using a two octet address field with bits 8 to 4 of the first address field octet and bits 8 to 2 of the second address field octet set to "1" and bit 3 of the first octet set to "0" as shown in Figure A-6/Q.922. The congestion indication bits and the discard eligibility indicator do not exist in this case.

Note – The use of the CLLM for semi-permanent frame relay connections using D-channel access requires further study.

Octets 1 and 2 of the XID frame represent the address field and bit 2 of octet 2 is the command/response bit (C/R). In a congestion control application, the receipt of a congestion message should not result in transmission of a subsequent frame, which would add to the traffic congestion. Therefore, the CLLM shall be sent in an XID response frame, i.e. the C/R bit shall be set to "1".

A.7.2 *Control field*

Octet 3 contains the control field code point for this type of message. This represents the control field for XID.

10/022,594

A.7.3 *XID information field*

A.7.3.1 *Format identifier field*

Octet 4 contains the format identifier field. ISO defines the format identifier field to have a length of one octet. ISO 8885 [15] assigns the value of 130 decimal as a general purpose format identifier, and it is used by layer management for parameter negotiation as discussed in Appendix III.

A.7.3.2 *Group field*

A.7.3.2.1 *Group identifier field*

Octet 5 contains the group identifier field. The group identifier field is "15" decimal, which is assigned by ISO 8885 [15] to indicate private parameters.

Note – In the context of ISO 8885 [15]-Addendum 3, "private" is taken to mean a parameter beyond the scope of the HDLC specific parameters defined in ISO 8885 [15].

A.7.3.2.2 *Group length field*

Octets 6 and 7 contain the group length field. This 16-bit field describes the "length" of the octets in the remainder of the group field. The maximum value of the group length field is 256 for compatibility with the D-channel applications where the information field is a maximum of 260 octets.

A.7.3.2.3 *Group value field*

The group value field consists of two or more parameter fields. The parameter Set identification, parameter 0, identifies the set if private parameters within the group value field per ISO 8885 [15]/DAD 3. The other parameters shall appear in the following order: cause identifier and then DLCI identifier.

A.7.3.3 *Parameter for parameter Set identification*

The parameter Set identification parameter shall always be present; otherwise, the frame shall be rejected.

A.7.3.3.1 *Parameter Set identification field*

Octet 8 contains the parameter identifier field for the first parameter and is set to "0" per ISO 8885 [15]/DAD 3. Parameter 0 identifies the set of private parameters within this group.

A.7.3.3.2 *Parameter Set identification length field*

Octet 9 contains the length of parameter 0 and is set to binary "4".

A.7.3.3.3 *Parameter value field*

Octets 10 to 13 identify that this usage of the XID frame private parameter group is for I.122 [11] private parameters. Octet 10 contains the IA5 value of "I" (binary 105). Octet 11 contains the IA5 value of "1" (binary 49). Octets 12 and 13 each contain the IA5 value of "2" (binary 50).

A.7.3.4 *Parameter field for cause identifier*

The cause identifier shall always be present; otherwise, the frame shall be ignored.

A.7.3.4.1 *Parameter identifier field*

Octet 14 contains the cause identifier field. When the parameter identifier field is set to "2", then the following octets of this parameter contain a length parameter set to "1" and a cause value.

A: 17/19

10/022,594

A.7.3.4.2 *Parameter length field*

Octet 15 contains the length of the cause identifier. This shall be set to binary "1".

A.7.3.4.3 *Cause value*

Octet 16 contains the cause value. This octet identifies the cause of this message as determined by the congested network node whose layer management module originated the message.

Bits 8 7 6 5 4 3 2 1	Cause
0 0 0 0 0 0 1 0	Network congestion due to excessive traffic — short term
0 0 0 0 0 0 1 1	Network congestion due to excessive traffic — long term
0 0 0 0 0 1 1 0	Facility or equipment failure — short term
0 0 0 0 0 1 1 1	Facility or equipment failure — long term
0 0 0 0 1 0 1 0	Maintenance action — short term
0 0 0 0 1 0 1 1	Maintenance action — long term
0 0 0 1 0 0 0 0	Unknown — short term
0 0 0 1 0 0 0 1	Unknown — long term
All other values are reserved	

The CLLM message shall not be ignored solely because of an unknown cause value.

Note – Cause values shall be coded as "short term" if the CLLM is sent due to a transient condition (e.g. one anticipated to have a duration on the order of seconds or minutes); otherwise, they shall be coded as "long term". Usage shall be network specific.

A.7.3.5 *Parameter field for DLCI identifier*

If the DLCI identifier is missing, then the frame shall be ignored.

A.7.3.5.1 *Parameter identifier field*

When the parameter identifier field is set to "3", then the following octets of this parameter contain the DLCI(s) of the frame relay bearer connection(s) that are congested.

A.7.3.5.2 *Parameter length field*

Octet 18 contains the length of the DLCI(s) being reported, in octets. For example, if (n) DLCIs are being reported and they are of length two octets each, this will be 2 times (n) in octet size.

10/022,544

A.7.3.5.3 *Parameter value field*

Octets 19 through to the FCS octets contain the DLCI value(s) which identify logical link(s) that have encountered a congested state. The DLCI field is 10 bits long and contained in bits 8 to 3 of the first octet pair and bits 8 to 5 of the next octet of the pair. The bit 8 of the first octet is the most significant bit and bit 5 of the second octet is the least significant. The bits 2 to 1 in the first octet and bits 4 to 1 in the second octet are reserved.

A.7.4 *FCS field*

The last two octets of the frame contain the frame check sequence field.

A.7.5 *Action of the congested node*

When a node becomes congested, it may send notification of the congested state by setting forward and backward congestion bits to "1" in the address field and/or using a consolidated link layer management message on the management data link. The purposes of the explicit congestion notification are:

1) to inform the edge node at the network ingress of the congestion so that the edge node can take appropriate action to reduce network congestion; and/or

2) to notify the source that negotiated throughput has been exceeded.

The consolidated link layer management message contains a list of DLCIs that correspond to the congested frame relay bearer connections. These DLCIs will correspond both to sources that are currently active and those that are not. The purpose of the latter action is to prevent those sources from becoming active and hence increasing congestion. It may be necessary to send more than one consolidated link layer management message, if all DLCIs cannot fit within a single frame.

ANNEX B

(to Recommendation Q.922)

SDL for point-to-point procedures

B.1 *General*

The purpose of this annex is to provide one example of an SDL representation of the point-to-point procedures of the data link layer, to assist in the understanding of this Recommendation. This representation does not describe all of the possible actions of the data link layer entity, as a non-partitioned representation was selected in order to minimize its complexity. The SDL representation, therefore, does not constrain implementations from exploiting the full scope of the procedures as presented within the text of this Recommendation. The text description of the procedures is definitive.

The representation is a peer-to-peer model of the point-to-point procedures of the data link layer and is applicable to the data link layer entities at both the user and network sides for all ranges of DLCIs. The model is the same as that used for Recommendation Q.921 [2] and Figure B-1/Q.922 demonstrates a graphical representation of the model.

10/022,594

8	7	6	5	4	3	2	1	
Flag								
0	1	1	1	1	1	1	0	Octet 1
High order octet of address field (Note)								2
Low order octet of address field								3
								4
Frame relay information field								
								N-3
Frame check sequence (FCS) 1st octet								N-2
Frame check sequence (FCS) 2nd octet								N-1
Flag								
0	1	1	1	1	1	1	0	N

Note – The default address field length is 2 octets. It may be extended to either 3 or 4 octets bilateral agreement.

FIGURE A-1/Q922

Frame relay frame format with two octet address

A.2.4 *Control field*

A control field, as seen by the DL-CORE Sublayer, does not exist in a frame relay frame structure.

A.2.5 *Frame relaying information field*

The frame relaying information field of a frame, when present, follows the address field (see § A.3.2) and precedes the frame check sequence field (see § A.2.7). The contents of the frame relaying information field shall consist of an integral number of octets.

The maximum number of octets in the frame relaying information field is defined in § A.5.1.

A.2.6 *Transparency*

A transmitting data link layer entity shall examine the frame content between the opening and closing flag sequences, (address, information and FCS fields) and shall insert a "0" bit after all sequences of five contiguous "1" bits (including the last five bits of the FCS) to ensure that a flag or an abort sequence is not simulated within the frame. A receiving data link layer entity shall examine the frame contents between the opening and closing flag sequences and shall discard any "0" bit which directly follows five contiguous "1" bits.

A.2.7 *Frame checking sequence (FCS) field*

The definition and use of the FCS is as described in § 2.7.

Q.922. Fig. A-1

10/022,994

Default address field format (2 Bytes)

8	7	6	5	4	3	2	1
Upper DLCI						*	EA 0
Lower DLCI				FECN	BECN	DE	EA 1

or

3 octet address field format

8	7	6	5	4	3	2	1
Upper DLCI						*	EA 0
DLCI				FECN	BECN	DE	EA 0
Lower DLCI or DL-CORE control						D/C	EA 1

or

4 octet address field format

8	7	6	5	4	3	2	1
Upper DLCI						*	EA 0
DLCI				FECN	BECN	DE	EA 0
DLCI							EA 0
Lower DLCI or DL-CORE control						D/C	EA 1

D/C DLCI or DL-CORE control indicator (see § A.3.3.7)
DE Discard eligibility indicator (see § A.3.3.5)
EA Address field extension bit (see § A.3.3.1)
* Bit intended to support a command/response indication. The coding is application specific (see § A.3.3.2)
FECN Forward explicit congestion notification (see § A.3.3.3)
BECN Backward explicit congestion notification (see § A.3.3.4)
DLCI Data link connection identifier (see § A.3.3.6)

FIGURE A-2/Q.922

Address field formats

Q.922, fig. A-2

10/022,594

d) contains a frame check sequence error;

e) contains a single octet address field; or

f) contains a DLCI which is not supported by the receiver.

Invalid frames shall be discarded without notification to the sender. No action is taken as the result of invalid frames.

2.10 *Frame aborts*

The definition of and the reaction to frame aborts is as in Recommendation Q.921 [2].

3 Elements of procedures and formats of fields for data link layer peer-to-peer communication

3.1 *General*

The elements of procedures define the commands and responses that are used for peer-to-peer communication using the data link layer connections.

Procedures are derived from these elements of procedures and are described in § 5.

3.2 *Address field format*

The address field format shown in Figure 1/Q.922 contains the address field extension bits, a command/response indication, 3 bits reserved for forward and backward explicit congestion notification and discard eligibility (used with frame relaying services per Annex A), a data link connection identifier (DLCI) field and a bit to indicate whether the final octet of a 3 or 4 octet "address field" is lower DLCI or DL-CORE control (see § 3.3.7) information. The minimum and default length of the address field is 2 octets and it may be extended to 3 or 4 octets to support a larger DLCI address range or to support optional DL-CORE control functions. The 3-octet and 4-octet address field formats may be supported at the user-network interface or at the network-network interface based on negotiation or bilateral agreement.

The support of address fields longer than two octets is an option chosen by bilateral agreement. This option includes distinctions for supporting the address field length varying on an interface basis or on a per channel basis.

3.3 *Address field variables*

3.3.1 *Address field extension bit (EA)*

The address field range is extended by reserving the first transmitted bit of the address field octets to indicate the final octet of the address field. The presence, of a 0 in the first bit of an address field octet signals that another octet of the address field follows this one. The presence of a 1 in the first bit of an address field octet signals that it is the final octet of the address field. For example, the two octet address field has bit one of the first octet set to "0" and bit one of the second octet set to "1".

3.3.2 *Command/response field bit (C/R)*

The C/R bit identifies a frame as either a command or a response. When the frame to be sent is a command frame, the C/R bit shall be set to 0. When the frame to be sent is a response frame, the C/R bit shall be set to 1.

3.3.3 *Forward explicit congestion notification bit (FECN)*

This bit is reserved for use with frame relaying service, as described in Annex A and Appendix I.

10/022,594

Default address field format (2 octets)

8	7	6	5	4	3	2	1
Upper DLCI						C/R	EA 0
Lower DLCI				FECN (Note)	BECN (Note)	DE (Note)	EA 1

or

3 octets address field format

8	7	6	5	4	3	2	1
Upper DLCI						C/R	EA 0
DLCI				FECN (Note)	BECN (Note)	DE (Note)	EA 0
Lower DLCI or DL-CORE control						D/C	EA 1

or

4 octets address field format

8	7	6	5	4	3	2	1
Upper DLCI						C/R	EA 0
DLCI				FECN (Note)	BECN (Note)	DE (Note)	EA 0
DLCI							EA 0
Lower DLCI or DL-CORE control						D/C	EA 1

EA	Address field extension bit
C/R	Command response bit
FECN	Forward explicit congestion notification
BECN	Backward explicit congestion notification
DLCI	Data link connection identifier
DE	Discard eligibility indicator
D/C	DLCI or DL-CORE control indicator

Note — See Annex A and Appendix I for the use of these 3 bits whiche are reserved for congestion notification signalling with frame relaying.

FIGURE 1/Q.922

Address field formats

10/022,594

3.3.4 *Backward explicit congestion notification bit (BECN)*

This bit is reserved for use with frame relaying service, as described in Annex A and Appendix I.

3.3.5 *Discard eligibility indicator (DE)*

This bit is reserved for use with frame relaying service, as described in Annex A and Appepndix I.

3.3.6 *Data link connection identifier (DLCI)*

The DLCI identifies a virtual connection on a bearer channel (i.e. D, B or H) at a user to network or network to network interface. Consequently, a DLCI specifies a data link layer entity to/from which information is delivered/received and which is to be carried in frames by data link layer entities. The DLCI field may be either unstructured or structured. In the former case, the least significant bit is determined as follows:

Address field size	D/C = 0	D/C = 1
2 octets	(Note)	(Note)
3 octets	bit 3 of octet 3	bit 5 of octet 2
4 octets	bit 3 of octet 4	bit 2 of octet 3

Note – Not applicable; least significant DLCI bit is bit 5 of octet 2.

A structure to the DLCI field may be established by the network at the user to network interface or at a network to network interface subject to negotiation or bilateral agreement.

For notation purposes, the 6 most significant bits (bits 8 to 3) in the first octet of the address field (which correspond to the SAPI field in Recommendation Q.921 [2]) are referred to as the upper DLCI.

Table 1/Q.922 shows the ranges of DLCI values which apply for specific functions to ensure compatibility with operation on a D-channel, which also may use the Q.921 [2] protocol. A two octet address field format for this Recommendation is assumed when used on a D-channel. For further study is whether 3 or 4 octet address field formats may be used on a D-channel.

3.3.7 *DLCI/DL-CORE control indicator (D/C)*

The D/C indicates whether the remaining six usable bits of that octet are to be interpreted as the lower DLCI bits or as DL-CORE control bits. The bit is set to 0 to indicate that the octet contains DLCI information. This bit is set to 1 to indicate that the octet contains DL-CORE control information. This indicator is limited to use in the last octet of the three or four octet type "address field". The use of this indication for DL-CORE control is reserved as there have not been any additional control functions defined which need to be carried in the "address field"; this indicator has been added to provide for possible future expansion of the protocol.

Note – The optional DL-CORE control field is part of the address field and therefore must not be confused with the control field of an HDLC frame as defined in Figure 1/Q.921.

3.4 *Control field formats*

The control field identifies the type of frame, which will be either a command or response. The control will contain sequence numbers where applicable.

Three types of control field formats are specified: numbered information transfer (I format), supervisory fractions (S format), and unnumbered information transfers and control functions (U format). The control field formats are shown in Table 2/Q.922.